



REMR TECHNICAL NOTE CS-MR-1.9

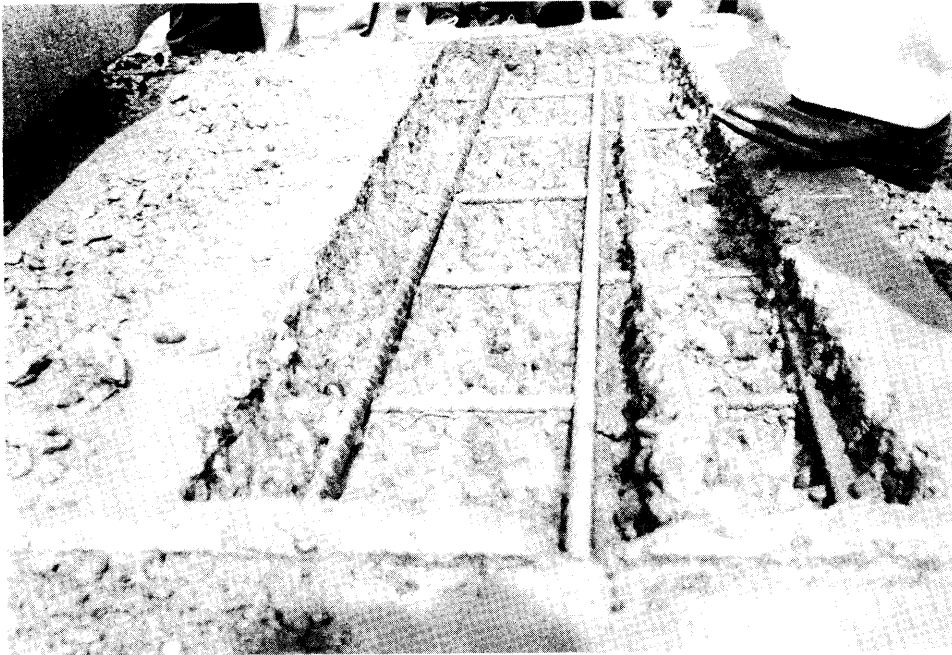
CONCRETE REMOVAL TECHNIQUE: WATER-JET
BLASTING

Figure 1. Water-jet blasting used to remove the deteriorated concrete, leaving steel reinforcement ready for reuse

PURPOSE: To describe the use of water-jet blasting as a technique for removal of deteriorated concrete.

APPLICATION: Water-jet blasting is most applicable for use in removing areas of deteriorated concrete where the steel reinforcement is to be reused in the replacement concrete (Figure 1). Automated systems are employed for removal involving large horizontal areas, such as bridge decks, pavements, and parking garage decks (Figure 2). Hand-held water-jet guns are used for removal involving difficult-to-reach areas and localized areas of deterioration typically at spalls and along joints and cracks (Figure 3).

Automated water-jet systems were successfully used to remove deteriorated concrete from the bridge decks at Grand Island, NY, and East St. Louis, IL. At Grand Island, rates in removing 3 to 6 in. of deteriorated concrete deck were increased to between 8 and 16 cu ft/hr by using two power units and a second nozzle (Ref a). The project was completed 14 months ahead of schedule; however, no cost savings were realized.



Figure 2. Demonstration of an automated water-jet system



Figure 3. A hand-held water jet used for localized areas of deterioration

At East St. Louis, a roto mill was used to cut the first 1 in. of deteriorated concrete from the bridge deck. The next 1/2 in. was removed using an automated water-jet system at an average removal rate of 15 cu ft/hr (Ref b). This exposed the tops of the steel reinforcing without damaging the reinforcing. A heavy chain was then dragged over the newly created surface to locate remaining areas of deterioration as denoted by a drummy sound. A minimum of 1.5 in. of additional concrete depth was removed at these locations, leaving the reinforcing fully exposed. In some areas the deterioration and removal extended through the full thickness of the deck.

ADVANTAGES: Water-jet blasting removes the deteriorated concrete, leaving the sound concrete virtually intact and the steel reinforcement undamaged for reuse in the replacement concrete. When removal is optimum, the reinforcing located within the removal area is left clean and free of corrosion and the newly created concrete surface rough and sound. These conditions are essential for good bonding of the new concrete.

LIMITATIONS: Commercially available automated systems are limited to removing concrete from horizontal surfaces. In general, these systems require 7,000 to 10,000 gal of water during an 8-hr operating shift. Debris remaining on the surface to be overlaid is usually removed by either hosing or vacuuming. Flows resulting from the water-jet operation must be controlled to prevent erosion of the surrounding areas such as soil embankments.

Water-jet guns produce a 40- to 50-lb thrust force (Ref c) that may be difficult to control safely in areas where insecure or unstable footing exists. When a gun is required to be operated from a scaffold or from an elevated work station, adequate harnessing or other means must be provided to prevent injury should an unexpected thrust cause the operator to fall. A face shield must be worn to protect the operator from fly rock.

Steel-toed shoes are required to protect the operator's feet from injury caused by accidental contact with the jetted stream of water. Additional safety requirements and procedures are required by Engineer Manual 385-1-1 to protect operating personnel from the effects of overexposure to the high levels of noise produced by the system. Typical noise levels produced are in the range of 90 db (Ref c).

PERSONNEL REQUIREMENTS: Highly trained, experienced personnel are required to operate and maintain water-jet equipment.

EQUIPMENT: Water-jet equipment used for bridge decks typically consists of a truck trailer containing a high-pressure pump, diesel engine, and water tank; a mobile blasting unit; and a high-pressure hose connecting the pump and blasting unit. Although the pump system may be capable of generating higher pressures, the maximum operating pressures generally used are in the range of 15,000 to 25,000 psi producing flow rates between 20 to 26 gpm. A water tank is required for water demands exceeding the system's storage capacity, which is most often less than 1,000 gal. The mobile blasting unit may be a remotely operated robot or an operator-driven unit. The nozzle operation is automated to travel back and forth along a guide rail at a programmed speed. Most systems have interchangeable rail systems of different lengths to provide desired removal widths. Water-jet guns are operated off the same pump as the mobile units. A vacuum system is an optional piece of equipment used to remove debris from within the removal area.

- REFERENCES:
- a. Concrete Construction. 1985 (Sep). "Waterblasting Robot Helps Complete Bridge Repair 14 Months Early," p 785.
 - b. Highway and Heavy Construction. 1986 (Aug). "Bridge Deck Rehab Zips Along with High-Pressure Water Jet," p 46.
 - c. Journal of Protective Coatings and Linings. 1985 (Aug). "Evaluation of Wet Blast Cleaning Units," p 34.

ENVIRONMENTAL CONSIDERATIONS: A determination should be made as to whether the area to be removed contains coatings or other materials that are considered to be hazardous or toxic. If present, proper handling and disposal under Resource Conservation and Recovery Act regulations may be required (see Technical Note EI-M-1.2, "Handling and Disposal of Construction Debris"). For removal in which no hazardous debris is produced and the debris is to enter a waterway, a determination of the change in water quality and its impact will be required.

COST: The cost of removing concrete from bridge deck surfaces using water-jet blasting varies widely between jobs and greatly depends on the size of the job and the strength of concrete to be removed. Estimated cost for removing concrete is given for three ranges of depth within the deck: for concrete above the top reinforcing mat of the deck, cost is between \$5 and \$7/sq ft; for concrete between the top of mat to 1 in. below the mat, cost is between \$8 and \$12/sq ft; and for concrete from 1 in. below top mat to the full depth of deck, cost is between \$25 and \$45/sq ft.